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yet to find one who will acknowledge his belief in this singular phenomenon. In a region of country, where snakes are so abundant as in some parts of the West, it would be very strange if they were not occasionally found in "dogtowns" as well as elsewhere. In the room in which my dogs were confined, was a cage containing two full-grown, living rattlesnakes. This gave me an excellent opportunity for testing the friendship of these animals for one another; but my cautious skepticism exceeded my curiosity, and my little friends did not, this time at least, fall victims to scientific experiments.

THE FLIGHT OF BIRDS AND INSECTS.

THE few last numbers of the French "*Revue des Cours Scientifiques*" (Nos. 36, 38, 40, 1870), which has been suspended since the siege of Paris, contain the reports of a course of lectures by M. Marey on this interesting subject. The distinguished lecturer has brought to bear on this difficult theme rare experimental and mechanical tastes, added to a nicety of manipulation characteristic of his countrymen.

Who of us, as remarked to the translator by an eminent ornithologist, can even now explain the long sustained, peculiar flight of the hawk, or turkey buzzard, as it sails in the air without changing the position of its wings? and, we would add, the somewhat similar flight of a butterfly? It is the poetry of motion, and a marvellous exhibition of grace and ease, combined with a wonderful underlying strength and lightness of the parts concerned in flight.

Before we give a partial account of the results obtained by the delicate experiments of Professor Marey, our readers should be reminded of the great differences between an insect and a bird, remembering that the former is, in brief, a chitinous sac, so to speak, or rather a series of three such spherical or elliptical sacs (the head, thorax and abdomen); the outer walls of the body forming a solid but light crust, to which are attached broad, membranous wings, the wing being a sort of membranous bag stretched over a framework of hollow tubes, so disposed as to give the greatest

lightness and strength to the wing. The wings are moved by powerful muscles of flight, filling up the cavity of the thorax, just as the muscles are largest about the thorax of a bird. Moreover in the body of insects that fly (such as the bee, cock-chafer and dragon fly), as distinguished from those that creep exclusively, the air tubes (tracheæ) which ramify into every part of the body, are dilated here and there, especially in the base of the abdomen, into large sacs, which are filled with air, when the insect is about to take flight, so that the specific gravity of the body is greatly diminished. Indeed, these air sacs, dilatable at will by the insect, may be compared to the swimming bladder of fishes, which enables them to rise and fall at will to different levels in the sea, thus effecting an immense saving of the labor of swimming. In the birds, as everybody knows who has eaten a chicken, or attended the dissection of a Thanksgiving turkey, the soft parts are external, attached to the bony framework comprising the skeleton, the wing bones being directly connected with the central back bone; so that while these two sorts of animated machines are so different in structure, they yet act in much the same manner when on the wing. The differences are clearly stated by Marey, some of whose conclusions we now give almost word for word.

The flight of butterflies and moths differs from that of a bird, in the almost vertical direction of the stroke of their wings, and

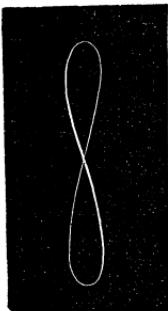
in their faculty of sailing in the air without making any movements; though sometimes in the course they pursue, they seem to resemble birds in their flight.

The flight of insects and birds differs in the form of the trajectory of the wing in space; in the inclination of the plane in which the wings beat; in the rôle of each of the two alternating (and in an inverse sense) movements that the wings execute; as also in the facility with which the air is decomposed during these different movements. As the wings of a fly are adorned

with a brilliant array of colors, we can follow the trajectory, or figure, that each wing writes in the air; it is of the form of a figure of eight (Fig. 9), first discovered by Professor J. Bell Pettigrew of Edinburgh.

By an ingenious machine specially devised for the purpose,

Fig. 9.



Marey found that a bird's wing moves in an ellipse, with a pointed summit (Fig. 10). The insect beats the air in a distinctly horizontal plane, but the bird in a vertical plane. The wing of an insect is impervious to the air; while the bird's wing resists the air only on its under side. Hence, there are two sorts of effects; in the insect, the up and down strokes are active; in the bird, the lowering of the wing is the only active period, though the return stroke seems to sustain the bird, the air acting on the wing. The bird's body is horizontal when the wing gives a downward stroke; but when the beat is upward, the bird is placed in an inclined plane like a winged projectile, and mounts up on the air by means of the inclined surfaces that it passively offers to the resistance of this fluid.

In an insect, an energetic movement is equally necessary to strike the air at both beats up and down. In the bird, on the contrary, one active beat, only, is necessary, the down beat. It creates at that time all the motive force that will be dispensed during the entire revolution of the wing. This difference is due to the difference in form of the wing. The difference between the two forms of flight is shown by an inspection of the two accompanying figures (11, 12). An insect's wing is small at the base and broad at the end. This breadth would be useless near the body, because at this point the wing does not move swiftly enough to strike the air effectively. The type of the insectean wing is destined, then, simply to strike the air. But in the bird the wing plays also a passive rôle, i. e., it receives the pressure of the air on its under side, when the bird is projected rapidly onward by its acquired swiftness. In these conditions the

Fig. 10.

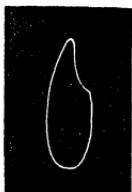


Fig. 11.



Trajectory of an insect's wing.

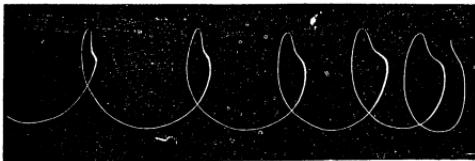
whole animal is carried onward in space; all the points of its wing have the same velocity (*vitesse*). The neighboring regions of the body are useful to press upon the air which acts as on a paper kite (*cerf-volant*). The base of the wing also in the bird, is broad and provided with feathers, which form a broad surface on

which the air presses with a force and method very efficacious in supporting the bird. Fig. 13 gives an idea of this disposition of the wing at the active and passive time in a bird.

The inner half of the wing is the passive part of the organ, while the external half, that which strikes the air, is the active

part. A fly's wing makes 330 revolutions in a second, executing consequently 660 simple oscillations; it ought at each time to impress a lateral deviation of the body of the insect, and destroy

Fig. 12.

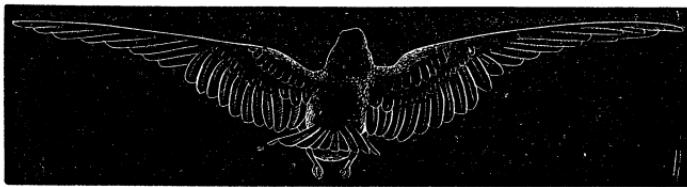


Trajectory of a bird's wing.

the velocity that the preceding oscillation has given it in a contrary direction. So that by this hypothesis the insect in its flight only utilizes fifty to one hundred parts (or one half) of the resistance that the air furnishes it.

In the bird, at the moment of lowering the wings, the oblique plane which strikes the air in decomposing the resistance, produces a vertical component which resists the weight of the bird's body, and a horizontal component which imparts swiftness. The horizontal component is not lost, but is utilized during the rise of the wing, as in a paper kite when held in the air against the wind. Thus the bird utilizes seventy-five out of one hundred parts of the resistance that the air furnishes. The style of flight of

Fig. 13.



birds, is, therefore, theoretically superior to that of insects. As to the division of the muscular force between the resistance of the air and the mass of the body of the bird, we should compare the exertion made in walking on sand, for example, as compared with walking on marble. This is easy to measure. When a fish strikes

the water with its tail to propel itself forward, it performs a double task ; one part consists in pushing backwards a certain mass of water with a certain swiftness, and the other in pushing on the body in spite of the resistance of the surrounding fluid. This last portion of the task only is utilized. It would be greater if the tail of the fish encountered a solid object. Almost all the propelling agencies employed in navigation undergo this loss of labor (*travail*) which depends on the mobility of the *point d'appui*. The bird is placed among conditions especially unfavorable.

Professor Marey ends his first lecture with a discussion of the division of the muscular force between the resistance of the air and the mass of the body of the bird. His second and third lectures are on the resistance of the air, illustrated by mathematical and physical data, and the exhibition of his peculiar and delicate machinery for solving these problems by actual experiment.

REVIEWS.

THE GEOLOGY AND PHYSICAL GEOGRAPHY OF BRAZIL.* — In gleanings after some of the most notable of the world's travellers who have visited Brazil, little enough would seem to be left for another explorer in the same field. By steadily pursuing, however, for the most part one line of study, though a most comprehensive one, our author as a geologist has brought together in this readable book a simple, clear, philosophic account of Brazilian geology in its widest sense, which, while doing justice to the preceding writers, contains a vast deal of novel information and does decided credit to American geographical and geological science. Our really good, carefully prepared books of travel can be counted on the fingers' ends. This new candidate for favor may well be included among the select few. In Humboldt's famous "Travels" and "Views of Nature" we have the results of years of travel by a natural philosopher; in Bates's and Wallace's narra-

* Thayer Expedition. Scientific Results of a Journey in Brazil. By Louis Agassiz and his travelling Companions. Geology and Physical Geography of Brazil. By Professor C. F. Hartt. With illustrations and maps. Boston: Fields, Osgood & Co., 1870. 8vo, pp. 620. \$5.00.